engaged in the labours of his office, believed that he had still many years to live. His death, however, took place three years afterwards; he passed away tranquilly and without suffering, on the 22nd of April, 1871, leaving six sons and two daughters to mourn his loss. His wife, with whom he had lived in happiness for many years, had preceded him so long ago as 1846.

To astronomers Schwerd is best known by his observations of circumpolar stars made in 1826, 1827, and 1828, at Speyer, a reduced catalogue of which was published by Oeltzen at Vienna, in 1856. The earlier numbers of the *Astronomische Nachrichten* also contain several observations made by him of occultations and comets, including Halley's Comet at its appearance in 1835. The small Observatory of the Lyceum, in which these observations were made, was built in 1823, and presented by King Maximilian Joseph with a 20-inch meridian-circle by Reichenbach and Ertel, which was first used in February, 1826. These, however, were by no means the whole of Schwerd's directly scientific labours. He made a valuable contribution to geodesy in the measurement of a base-line in the Palatinate, and comparing it by triangulation with the longer one measured under royal authority by Laemmle in 1819–20. He also distinguished himself in the field of optical inquiry, and in the year 1835 published a work on the "Analytical Development of the Phenomena of Diffraction derived from the Fundamental Principles of the Undulatory Theory of Light." It is only necessary to mention here one other of the many labours of Professor Schwerd,—the construction of a new kind of prism-photometer, about the same time that Sir John Herschel was using his astrometer at the Cape of Good Hope. With this instrument, which he contrived at Munich, Schwerd made many measures of the quantity of light given out by several of the brightest stars. He was elected an Associate of this Society in 1837.

W. T. L.

Proceedings of Observatories.

Royal Observatory, Greenwich.

The usual course of observations with the Altazimuth was interrupted in the latter part of the year by the dismounting of the instrument, in order that the pivots of its horizontal axis might be repaired. With the view of securing a better determination of the zero of azimuth, the practice was introduced in November 1871, of observing, when practicable, a low star instead of the collimator for combination with a high star; this soon revealed the existence of discordances in the zero of azimuth as determined from the high and the low objects, which could only arise from irregularity of the pivots of the horizontal axis. On examination these were found to be much cut, and the instrument was, in consequence, dismounted on 1872, September 20, so that the pivots might be re-turned, and new segmental bearings made

similar to those which have been so successful in the case of the Transit Circle. This proved a more troublesome operation than had been anticipated, and the instrument was not brought into use again till 1873, January 8. Whilst the pivots were being repaired the opportunity was taken of making several minor alterations, the chief being that the levels can now be conveniently read off from below by means of mirrors suitably placed above them; for this it was necessary to have the divisions etched on the glass. It is hoped that the improvement in the form of the bearings, combined with due attention to the lubrication of the pivots, will effectually preserve them from injury in future.

The system of star-observing with the Transit Circle has been considerably extended by the formation of an extensive working catalogue containing, in addition to stars for other purposes, all circumpolar stars down to the sixth magnitude, to be observed assiduously both above and below the Pole, as a check on the collimation error. No sensible change appears to have taken place in the discordance between the results of the Nadir observation and of Reflexion Stars; by the application of a correction to the former the determination of zenith-point is practically made to depend on the results of star observations alone.

The Normal Sidereal Clock has fully maintained its character for steadiness of rate throughout the year; the increase of daily losing rate due to the barometric inequality appears to be $0^{s}\cdot31$ for 1 inch rise of the barometer, while accidental variations in the personal equation of the observers completely mask any other irregularity of the clock.

For the phenomena of *Jupiter's* satellites, of which an unusually large number have been observed, the Great Equatoreal has been almost exclusively used, and by its means estimations have, in several instances, been made of the phases of the eclipses. These observations will be found in the *Monthly Notices*.

The observations with the Water Telescope have been brought to a satisfactory conclusion, as will be seen from the subjoined results for the latitude of the instrument, which show by their close agreement that there is no sensible error in the co-efficient of aberration adopted in the *Nautical Almanac*.

	Spring.	Autumn.
1871 ..	51° 28′ 34″·4	51° 28′ 33″·6
1872 ..	51 28 33·6	51 28 33·8
Means	51 28 34·0	51 28 33·7

The volume for 1870 was distributed last summer, but the printing of the next volume is not so forward as usual, though all the MSS. for 1871 were in the printer's hands at an early period.

As it has been decided to include solar spectroscopy in the regular course of observations, a spectroscope to be attached to

the Great Equatoreal has been designed for this purpose, as well as for observations on stars and nebulæ, and is now in course of construction. The valuable series of Sun pictures, taken with Mr. De La Rue's photoheliograph at Kew, is to be continued with the same instrument at Greenwich, and a building has been prepared in which it will be installed in the course of a few days. The continuity so necessary in such records will thus be preserved nearly unbroken.

Active preparations have been going on during the past year for observation of the approaching Transit of *Venus*. Nearly all the instruments are now ready, and suitable huts have been erected for them, twenty in all being required. Several of the intending observers have thus been enabled to acquire that dexterity in the use of the instruments which practice alone can give, whilst some trifling deficiencies in the original equipment, pointed out in this way, have been supplied. All the forms for computation have been printed, and their efficiency tested in actual work. The importance of these early preparations cannot be over-estimated, and in this respect England will have the great advantage of being able to test thoroughly any improved methods of observation that may be suggested. The erection of the observing huts has also proved useful to a party of officers of the Royal Engineers, who came to the Observatory to practise the observations required for the continuation of the Arc of the Parallel forming the North American boundary.

The Royal Observatory has co-operated in a telegraphic redetermination by means of the French Atlantic Cable of the differences of longitude between Washington, Paris, and Greenwich, undertaken by Professor Hilgard of the United States Coast Survey.

Since the last Report of the Council the Observatory has lost the valuable services of Mr. Carpenter, who resigned his post at the end of last September; after a lapse of more than three months Mr. Downing, of Trinity College, Dublin, has been appointed his successor. The inconvenience of this delay would have been severely felt but for the dismounting of the Altazimuth.

Radcliffe Observatory, Oxford.

The only alteration during the past year in the establishment of this Observatory, consists in the addition of a computer.

The reports of former years will show that the work undertaken was slightly in excess of the powers of the computing forces, and on this being represented to the Board of Trustees, they, with their accustomed liberality, sanctioned for a limited time the additional expense thereby incurred. The establishment of assistants is the same as in former years, Mr. Lucas and Mr. Keating occupying the posts of first and second assistant; and the two computers are Mr. Luff, who has for so many years so zealously assisted

in the reduction of the observations, and Mr. Frederick Bellamy, who has been recently engaged. The good effects of the addition are already very striking, and it is hoped that all arrears of reductions will, in the course of the present year, be almost, if not altogether got rid of.

It will be also gratifying to the members of the Society to learn that Oxford is now included in the list of inland meteorological stations which send daily results by telegram to the Meteorological Office in London; Mr. Lucas, with his usual zeal, having undertaken to forward the necessary observations.

With regard to the astronomical observations of the past year, it will be sufficient to say that they have been carried on with all possible vigour and uniformity, though the wet and gloomy character of the year has contributed, as probably in all other places, to make the numbers considerably smaller than usual. In addition to the ordinary observations with the transit-circle and the heliometer, there have been, however, fourteen observations of occultations of stars by the Moon, besides a large number of observations of phenomena of *Jupiter's* satellites which are printed in the *Monthly Notices* of the Society.

The reductions are going on with vigour. All the transits are reduced to the end of 1872, and the observations of zenith distance will soon be completed to the end of 1871; while all the occultations which have been observed up to the present time, are reduced and ready for press, as well as all other extra-meridional observations.

A great portion of the two-hourly meteorological results for 1870 (as well as a portion, comprising the wind-results for 1871) are reduced to numbers, and it is hoped that in the course of the present year a great portion of the arrears will be got rid of.

Nothing has yet been done towards the compilation of the Third Radcliffe Catalogue, but it will soon be possible to undertake it.

The printing of the volume for 1870 is going on steadily, and some copies of the catalogue of stars for that year (about 1450 in number) will be ready shortly.

Cambridge Observatory.

The new Transit Circle continues to be employed in the observations of the small stars down to the ninth magnitude, included in the zone, lying between 25° and 30° of North Declination, a work which it will require some years to complete.

As was mentioned in last year's Report, this work has been undertaken with the view of assisting in carrying out the plan formed by the German *Astronomische Gesellschaft* for observing all the stars to the ninth magnitude inclusive, contained in Argelander's *Durchmusterung des Nördlichen Himmels*.

Since the last Report some alterations have been made in the

mode of observation. At the beginning of the year the instrument was set by the circle observer by means of the tangent screw, and the bisection was made by the transit observer using the other handle of the tangent screw. It was soon found, however, that even within the range of half a degree in declination, this mode of setting the instrument caused too great a delay, and was accompanied by a noise which was somewhat disturbing to the transit observer. In order to obviate this inconvenience, Mr. Graham was led to devise a very simple method of setting the instrument, which has since been employed with perfect success. One end of a cord is looped over the object-end of the telescope, the cord then passes round a pulley placed at the foot of the south collimator pier, thence it passes round a second pulley placed within reach of the circle observer when standing at the pointer microscope, and thence again round a third pulley close to the first, from which it passes to the eye-end of the telescope, round which it is again looped. By simply pulling the cord the instrument can be set in a few seconds with much greater accuracy than is attainable with the usual setting circle at the eye-end. To unclamp, set and clamp again, requires not more than five seconds. The transit-observer then roughly bisects the star by means of the tangent screw, gives the signal for reading off the microscopes, registers the transits across three wires, leisurely bisects with the micrometer-screw, and then reads and records the micrometer-head; the circle observer meanwhile reading off and recording two opposite microscopes and the pointer microscope, and selecting from the working catalogue the next star to be observed. In this way it is found that forty stars per hour can be easily and satisfactorily observed. It will be noticed that the rough bisection only is now made by the tangent screw, the final touches being given with the micrometer screw, which allows the bisection to be made with greater delicacy. Hitherto the zones thus taken have been limited to one degree in breadth, but, if necessary, the breadth could be easily increased. The requisite number of standard stars for clock correction are taken either in the course of the zone or immediately before and after; always in the course of the zone when the night is uncertain, as has been frequently the case during the past year. *Polaris* is regularly observed for azimuthal deviation of the instrument. The level and collimation errors are determined at least twice a week, and the nadir point nearly every day on which observations are made.

An instrumental error, which has caused us much trouble, was detected in October, 1871, in consequence of a suggestion made by Dr. Robinson, of Armagh. When the instrument is turned through the south horizon to the nadir, the reading of the observed nadir point is about $1''{\cdot}5$ in excess of that which is obtained when the instrument is turned through the north horizon to the nadir. Many experiments have been made to ascertain the cause of this discrepancy. At first it was imagined that the

clamp, by which the eye-piece—which is very weighty—is secured in its place within the telescope tube, might possibly permit a slight amount of shake, and in order to prevent this, three screws were inserted near the end of the telescope tube, so that their ends could be brought to bear on the tube of the eye-piece at some distance from the plane of action of the clamp. The springs which secure the lenses of the object-glass in their cell were also strengthened and made to act independently on the two lenses. The nadir point has been observed with the instrument unclamped, and even with the clamping apparatus entirely removed, and the weights of the counterpoises have likewise been reduced. These alterations, however, seem to produce no appreciable effect on the instrumental error in question. The error is exactly of the same kind as that which would take place if the screws by which the telescope-tube which carries the eye-piece is fastened to the central cube were not perfectly tight. These screws, however, have been forced as tight as can be done with safety, and Professor Adams fears that there is a defect at some point of the tube itself so that it yields to a certain extent and does not recover itself until its weight is brought to act in the opposite direction. If this be the case, the only cure of the evil will be to replace the faulty tube by a new one. Fortunately the error appears to be remarkably constant in amount, and as care is always taken first to direct the instrument to the horizon on the same side of the zenith as that in which it is to be employed, allowance may be made for its effects.

Forms and tables have been prepared for facilitating the reductions, the coefficients for level and collimation errors, and the nadir points are all calculated. The reductions of the standard stars, and the determination of clock corrections, are in progress, and a mode has been devised which will greatly facilitate the reductions to the centre wire of the observations of the zone stars, which are necessarily all broken observations.

The labour connected with the meteorological observations has been somewhat increased, as this observatory has been made one of the stations from which daily telegraphic communications are sent to the Meteorological Office in London.

A very excellent barometer has been procured from Adie, which is mounted in the transit-room.

Royal Observatory, Edinburgh.

During the past year the daily public distribution of time by electric time-ball, time-gun and controlled clocks, has continued as usual, with the addition of a new public controlled clock with its own circle of affiliated clocks in the University of Edinburgh, and a new gun-signal at Dundee; the Edinburgh Observatory's determination of Greenwich time being conveyed to the Dundee gun by the telegraphic system of the General Post Office in Edin-

burgh. The computation of the bi-daily Meteorological Observations at fifty-five stations of the Meteorological Society of Scotland, for the Registrar General's Quarterly and Annual Returns has also been continued in the Observatory.

Further, during the past year the printed Edinburgh observations down to 1870, with portions of 1871, have been distributed; together with a compendious representation of the whole of the meteorological computations for Scotland prepared in the Observatory for the Registrar General from 1858 downwards.

In February 1872, the Edinburgh Astronomer having failed, after formal application, to obtain any assistance from the Government grant to the Royal Society, proceeded at his own expense to Palermo, with a but poorly fitted out spectroscope arrangement of his own construction; and in company with Signors Cacciatore and Tacchini of the Royal Observatory of that southern city, succeeded in making there repeated satisfactory observations of the spectrum of the Zodiacal Light, with a result not in accordance with the views previously held by some very high authorities.

The new equatoreal of two feet aperture for the Edinburgh Observatory by Mr. Howard Grubb of Dublin, was erected in all its larger and more essential parts punctually according to contract towards the end of last month; but is now waiting for some of its finer fittings and subsidiary arrangements, as well as certain necessary alterations to the building before its use commences. What has been done so far, in its main erection, reflects the utmost credit on Mr. Grubb and his men, who toiled through nearly the whole of December, in the darkest and most rainy period almost ever known, putting the instrument together chiefly by the light of hand-lamps, in order that the time-requirements of the contract should be as punctually fulfilled in an astronomical instrument-making contract as in any other.

Dunsink (Dublin) Observatory.

During the past year Dr. Brünnow has continued the observations on the parallax of stars, and he has also observed such double stars as are of special interest on account of their established or suspected orbital motion. The second part of the observations has been printed, and will be published in a few weeks.

Dr. Brünnow has also observed the planet *Phocea* during the months of August and September, using as comparison stars those selected beforehand by Professor Galle, with a view of determining the parallax of the Sun, but it is feared that this labour was lost, as it seems that no corresponding observations were made in the southern hemisphere.

The new meridian-circle which has been ordered from MM. Pistor and Martins, of Berlin, has not yet arrived, owing to some unavoidable delays, but the instrument is now nearly ready, and

is expected soon to be mounted in the Observatory, as all the alterations in the meridian-circle room have been completed during the year, and everything is ready for its reception.

Glasgow Observatory.

The operations at the Glasgow Observatory during the past year have consisted mainly in the reduction of the star observations which have been accumulating for several years, and which it is proposed shortly hereafter to publish. The objects whose places have thus been determined with the transit circle generally range between the sixth and ninth magnitudes, and include about four thousand of the stars in Bessel's zones. The meteors of November 27 were seen under exceptionally favourable circumstances, and it is believed that a fair determination has been obtained of the position of the radiant-point and of the time of maximum of the shower. The system of meteorological observations conducted by means of self-recording instruments, which has been established under the auspices of the Meteorological Committee of the Royal Society, continues in full operation. A quarterly publication, embodying a discussion of the results obtained at the seven affiliated observatories, now issues regularly from the office of the Committee in Victoria Street, Westminster.

Liverpool Observatory, Bidston, Birkenhead.

The work at this Observatory has been chiefly confined to the communication of time to the Port, the testing of nautical instruments, and to meteorological observations.

The arrangements for firing the time-gun, which is placed on the Morpeth Dock Pier Head, about three miles from the Observatory, were formerly such as to cause some trouble in consequence of the controlled clock not being sufficiently powerful for the purpose for which it was intended. Mr. Ritchie has therefore erected a new clock of much greater power in a building a few yards from the gun, and since these alterations have been made the performance of the gun-clock has been satisfactory. The flash of the gun is well seen from the Observatory, and is compared daily with the normal clock, the errors of which, as found from subsequent observations, can be obtained at the Observatory for each day of the year.

Since the new regulations for the trial of chronometers came into operation more than a thousand of these instruments have been tested at the Observatory. The method of trial adopted by Mr. Hartnup is to find the rates of the chronometers in the two extreme and middle temperatures to which they are generally exposed at sea. The chronometers employed in the mercantile navy are almost universally furnished with that which is known as the ordinary compensation-balance; and it is well known that

chronometers with this balance when adjusted for high and low temperatures go faster at the intermediate temperatures than at either of the extremes. To show the amount of error caused by this defect in the ordinary balance in so small a range of temperature as thirty degrees of Fahrenheit it is absolutely necessary to have the means of subjecting the instruments to three definite temperatures; such means have been provided at the new Observatory, and all the chronometers on trial are exposed to definite temperatures in the following order:—55°, 70°, 85°, 70°, 55°, a change of 15° being made at the end of each week. Abstracts of the rates so found are printed at the end of each year, and the results up to the present time show,—

1st. That the rates of about ten per cent of the chronometers tested are so irregular as to render the instruments quite unfit for nautical purposes.

2nd. That the error of thermal adjustment between the temperatures of 55° and 85° is often such as to cause a change of rate to the amount of many seconds a day.

3rd. That the best made and most carefully adjusted instruments when shown by the trial to have the same rate in 55° and 85° gain on the average six-tenths of a second a day more in 70° than at either of the above-named extremes; and that when they are found to have the same rate in either 55° and 70°, or 70° and 85°, they lose more at the other extreme of 85° or 55°; the average amount being one second and a half a day.

It will be seen from the above that chronometers which have been carefully adjusted for the temperatures 55° and 70°, or 70° and 85°, are liable between the extremes of 55° and 85° to an alteration in their daily rates of one second and a half for a change of temperature of 15° of Fahrenheit.

Two meteorological telegrams, containing information useful to the shipping interests, are sent daily from the Observatory to Liverpool; weekly meteorological results are supplied to the Medical Officers of Health for Liverpool and Birkenhead, and the Registrar General is supplied with weekly and monthly meteorological results.

Durham Observatory.

During the past year the scheme of observations that has been hitherto pursued has been greatly interfered with by the unsettled state of the government of the Durham Observatory, as well as the very unfavourable weather experienced in the north of England. That scheme embraced the extra-meridional observation of those minor planets whose orbits were imperfectly known, but the necessity for a large instrument to perform this work satisfactorily is yearly becoming greater. Finding the equatoreal more and more inadequate for the work, it appears that the time is now come to discontinue the attempt, and to leave this branch of astronomy to the care of the Continental observatories, which have so perseveringly followed it. It is not without

regret that this statement is made, but it is hoped that the resources of the Observatory may be more usefully employed in other directions. Phenomena of an occasional character will in future form the principal objects of observation. Comets, when discovered, will be observed with the equatoreal, and a few planets will be occasionally followed beyond the limits of the Berlin ephemerides when such observation is likely to advance our knowledge of their orbits. Ephemerides will also be computed for this purpose when necessary, and it is believed that this limitation of work will be approved by astronomers.

The meteorological observations are continued with the usual regularity, and now form the most valuable series in this part of England.

Kew Observatory.

The Photoheliograph was worked regularly up to the end of March, 1872, namely, a month beyond the period originally contemplated, in order to complete the ten years' series of observations. The measurements and reductions of the Sun-pictures are being continued at the expense of Mr. De La Rue; the results for the years 1867, 1868, and 1869, are in course of printing in the *Phil. Trans.* The remainder of the pictures—namely, those of 1870, 1871, and up to March 31, 1872—will be measured and reduced during the current year.

Photographs have been obtained of a scale of equal parts, 15 feet in length, which has been temporarily erected, with the sanction of Her Majesty's Office of Works, on the Pagoda at Kew, distant 4398·24 ft. from the photoheliograph. The divisions of the scale consist of plates and intervening spaces, both exactly 1 foot wide, and consequently subtending an angle of 46″·9. The measurement of the pictures of this scale, which has been photographed in different positions across a diameter of the field, will serve to determine the correction for optical distortion. In the photographs the straining rods of the structure which carries the plates, and which subtend an angle of only 0″·9, are well defined.

A photoheliograph for Pulkowa, intended for observations of the transit of *Venus*, was, previous to being sent to its destination, taken to the Kew Observatory, and photographs of the scale were obtained with it. The measurement of these pictures will determine the optical character of the instrument, which has been constructed by Mr. Dallmeyer, and which appears to be nearly, and possibly entirely, free from distortion.

The measurements of the scale-photograms are deferred for a short time, as the micrometer is still in use for the Sun pictures.

Since March, when the Sun-photograms were discontinued, eye-observations of the Sun, after the method of Hofrath

Schwabe, have been made at Kew with a telescope $2\frac{3}{4}$ inches aperture.

The Kew photoheliograph will be shortly erected and worked at the Royal Observatory, Greenwich.

Stonyhurst Observatory.

In consequence of the very cloudy state of the sky during the past twelve months, any continuous series of astronomical observations has been rendered almost impossible.

An attempt is being made to see how far this Observatory might be able to aid in supplying the complete series of observations of the phenomena of *Jupiter's* satellites required for the correct theory of the planet; but, although one of the assistants has devoted considerable time to the subject, the clouds have made all his efforts fruitless.

The continuous registration of every variation of the Earth's magnetism, and of all the most important meteorological changes, made it very desirable to obtain a simultaneous record of the alterations daily taking place on the solar surface, as thus this Observatory might be made a complete physical establishment. Some further steps have been taken this year to ensure the completeness of the arrangements.

A reduction of the whole of our daily magnetic traces, as a preliminary step to the intercomparison of simultaneous solar, meteorological, and magnetic phenomena, has been started this year, and has already made fair progress.

A paper on the results of the Magnetic Survey of the whole of Belgium, made last year with the Stonyhurst instruments, has been communicated to the Royal Society.

Temple Observatory, Rugby.

This is an observatory founded at Rugby in memory of the present Bishop of Exeter, late Head Master of Rugby School. It consists at present of a small wooden observatory, containing the $8\frac{1}{4}$-inch equatoreal made by Alvan Clark for Dawes, and a $12\frac{1}{8}$-inch reflector by With, mounted by Mr. Seabroke, and a dark room for spectroscopic work.

The observatory is used for educational purposes, and the work of observing is therefore much interrupted.

Mr. Seabroke has mapped the solar prominences on nearly every day on which the Sun has been visible, and has compared in part the spectra of hydrogen and nitrogen and various low pressures directly with the solar spectrum.

Mr. Wilson and Mr. Seabroke have measured a considerable number of double stars.

Drawings of Sun-spots, Encke's Comet, *Venus*, *Jupiter*, and *Mars*, have been made repeatedly by some of the boys, who also assist in double-star measuring, and in some of the calculations.

Lord Lindsay's Observatory, Dun Echt, Aberdeen.

During the past year the arrangements have been made, and rooms completed for the reception of the following instruments,—

1. A transit circle by Troughton and Simms similar (with some modifications) to the new circle at Cambridge by the same makers. Aperture of object-glass, 8 inches. Focal length, 8 feet, 6 inches. Both circles finely divided, each of 3 feet in diameter, and reading by 8 microscopes.

2. An equatoreal by Grubb of Dublin, somewhat similar to the Royal Society telescope by the same maker, and at present in the hands of Dr. Huggins. Aperture of object-glass, 15 inches, focal length, 15 feet.

3. An equatoreal by T. Cooke and Sons of York, of 6 inches aperture, and 6 feet focal length.

4. A heliometer, of 4 French inches aperture by Repsold of Hamburg. This instrument is exchangeable with the telescope of the Cooke equatoreal, so that either the one or the other can be used on the same stand.

5. A silver on glass Newtonian reflector of 13 inches aperture (formerly Mr. Gill's telescope), equatoreally mounted, focal length, 10 feet, 6 inches. This instrument has also Cassegrain mirrors, equivalent to a focal length of 40 feet.

6. A large chronograph with four barrels.

7. An altazimuth by Troughton and Simms, with circles of 12 inches in diameter.

Besides these there are, in course of construction, a large "Foucault Siderostat," a portable transit, and some minor instruments for which as yet no buildings have been erected.

Excepting the 12 inches altazimuth, none of the other instruments have yet been received from the makers.

The Grubb equatoreal should have been completed last September. The stand and tube are finished, but it was not until July last year, or eleven months after the order was given, that Mr. Grubb succeeded in obtaining from Messrs. Chance two sufficiently perfect discs of glass.

Mr. Grubb hopes to have the instrument ready for trial by the end of February.

The heliometer is promised by Messrs. Repsold in September.

The reflector is having various alterations made upon it by Mr. Grubb, to adapt it for solar photography, for use in the latitude of the Mauritius.

The transit-circle should have been completed and erected long ago, but the makers seem to have encountered some unforeseen causes of delay.

The mirrors of the Siderostat have been completed in the

National Observatory of Paris, by Monsieur Martin and have been very highly reported on.

The work of the past year has chiefly consisted in the completion of the various buildings, piers, shutters, domes, etc: the planning of instrumental and observing details, and in experiments and arrangements for the observation of the transit of *Venus* at the Mauritius in 1874.

An approximate determination of the latitude has been made by observations of *Polaris* with the altazimuth, giving a result of

$$57^\circ\ 9'\ 36''\ \text{N.}$$

The Astronomer's house, and laboratory, will be completed by the end of June, by which time it is believed that most of the instruments will be erected and adjusted, and Lord Lindsay and Mr. Gill hope then to begin systematic work.

Mr. Barclay's Observatory, Leyton.

During the past year the principal work has been the measuring of the angles of position and distances of double-stars, binary, and those suspected of motion. These observations are intended to form Vol. III. of the *Leyton Observations*, and it has been thought by Mr. Barclay that the more frequent publication of the observations would be acceptable, for though the book would necessarily be small (Mr. Talmage being alone in charge of the observatory), the rapid publication of reduced observations commends itself to all.

Comets, occultations, and phenomena of *Jupiter's* satellites, are also observed with the 10-inch equatoreal.

The instrumental part of the observatory is the same as described in Vols. I. and II. of the *Leyton Observations*, with the exception that gas is now "entirely" used to illuminate the field of the equatoreal, oil being dispensed with.

Different-coloured glasses (white, yellow, and red) have been used to colour the field, for it has been found that in different states of the atmosphere, a "small" star may be better seen, or a "close" star better divided, with, for instance, a yellow than with a red field.

Mr. Buckingham's Observatory, East Dulwich.

The large refractor, of $21\frac{1}{4}$ inches clear aperture, has been employed during the past year in the examination of the physical appearance of the planets, but owing to Mr. Buckingham's frequent absence, and the unusually cloudy state of the weather during the last six months, very few observations have been made. Some measures of *Jupiter*, *Neptune*, and double-stars

have, however, been observed; some of the latter, whose components are very close, have been divided for the first time. Mr. Buckingham took advantage of some brilliant days in April, May, and June, 1872, to observe *Jupiter* in daylight, with his great refractor, using the full aperture. The contrasts of colour on his surface and the belts were better seen than by night. On several occasions, notably on May 5, at 4 P.M., and on June 1, at 1 P.M., the satellites were seen.

The great refractor has also been employed in a scrutiny of the trapezium in the nebula of *Orion*, both with high and low powers; no trace, however, of any star can be seen within it. On favourable occasions, Mr. Buckingham has devoted particular attention to the examination of the solar surface, and more especially of the bright granules, which evidently play so important a part in the illuminating power of the Sun. Mr. Buckingham hopes that he will soon be in a position to lay the results of his observations before the Society. The Moon's surface has also been occasionally examined.

The instruments now in use at this observatory are a transit-instrument of 3 inches aperture, by Troughton and Simms, the great refractor, a good chronograph, and an excellent sidereal clock. The equatoreal, with a 9-inch object-glass by Wray, driven by a clock devised by Foucault, and made by Secretan, of Paris, has been lately dismounted.

Mr. Knott's Observatory, Woodcroft, Cuckfield.

Observations of variable stars have been continued during the past year. At the end of February a maximum of U *Geminorum* was observed, on which occasion the star remained for twelve days of and above the 10·3 magnitude.

Measures with the wire micrometer of a few double-stars have been also obtained.

A persistent rainfall and heavy ground mists have much interfered with observatory work.

Royal Observatory, Cape of Good Hope.

The attention of the staff has been chiefly directed to the reduction and printing of the observations made with the transit-circle, 1856–61. The results for 1857–58 have been printed and forwarded to England for distribution. The results for 1859 are printed to the end of the Star Catalogue. The whole of the star reductions for 1860 are ready for press. A general catalogue has been formed from the star observations, 1856–1860. The few Southern stars observed in 1861 out of the range of the Northern observatories have also been included. The catalogue contains 1159 stars, and is com-

plete, except the secular variations and the proper motions of some of the stars.

The Star Ledger for 1871 is ready for press. The catalogue of close circumpolars has been forwarded to the Society for publication, and appears in the *Monthly Notices* for November, 1872. More than 200 stars between 165° and 175° N.P.D. have been observed during the year 1872. The stars have been, with few exceptions, observed three times. The November meteors were carefully looked for during many nights about November 13, but the sky was generally clouded, and but very few could be seen.

Many meteors however appear to have been seen in parts of the Colony where the sky was clear, but no observations have been received to fix the radiant-point.

A return-signal has been arranged for after the drop of the Port Elizabeth time-ball. The distance over which the wires are carried is nearly 600 miles. The return-signal reaches the Observatory from $\frac{3}{10}$ to $\frac{6}{10}$ of a second after the current leaves the Observatory.

The instrumental equipment of the Observatory is in many respects defective, but some additions are under the consideration of the Lords of the Admiralty. The work of the Observatory has been much impeded by serious illness amongst the staff, and the long delay which has taken place in filling up the third assistantship, which has been vacant more than two years.

Melbourne Observatory.

During the year preceding Mr. Ellery's Report to the Board of Visitors for 1872, the transit-circle had been employed for the most part in observing stars for clock-error and for the determination of the position of the instrument. All the R.A. observations were completely reduced, and those for N.P.D. nearly so to the end of 1871.

A general catalogue of stars resulting from all the meridional observations made at this Observatory has been for some time in preparation. This has been found to be a most laborious and tedious work; but it is now far advanced towards completion. The year 1870 has been adopted as the epoch of the catalogue.

The observation of the Melbourne Zones of the Southern Survey has been suspended, as the calculations were getting too far behind. The number of small stars observed at this Observatory, on account of the Survey, amount to 48,672, and the number reduced to 36,917.

The great equatoreal has been employed on miscellaneous observations, including measures and drawings of the nebula and stars near η *Argûs*, observations of *Sirius* and companions, of *Venus*, *Jupiter*, and *Saturn*, *Antares*, H. 3722, 30 *Doradûs*, *Orion*, *Rigel*, *Achernar*, and *Canopus*. Every favourable oppor-

tunity has also been taken for scrutinising the Moon's surface, for revision of the lunar maps of the British Association Committee.

Mr. Ellery states that the work with the Great Melbourne Telescope has been much impeded by bad weather, moreover, that the Observatory has been without an observer for three months, Mr. Le Sueur's successor having resigned, and that he has had to work the Great Telescope himself; a new observer was about to be appointed about the middle of December last. Both the large mirrors require repolishing, but Mr. Ellery does not mean to attempt this critical work until he can command with comparative certainty the production of the parabolic figure; in the meantime, however, he has been giving much time to the experimental figuring of 12 and 9-inch mirrors, and has thus gained much experience in the management of figure especially with the aid of Foucault's method of testing, which he has adopted. He states, under date of Dec. 6, 1872, "I have got a magnificent 9-inch finished, and the polish is exquisite; it was obtained with a polisher made with the grinder covered $\frac{1}{20}$ of an inch with a mixture of 1 part rosin and 4 of bees'-wax, *scraped* until in contact everywhere with the speculum. The surface is like quicksilver, the blackest polish I have ever seen, without any trace of *scratches;* it performs with 600 admirably." It is evident that Mr. Ellery is on the right track, and that he will soon feel confidence in attacking the repolishing of the large mirrors.

It will be recollected that Mr. Ellery sent over last year an enlarged positive copy of a photograph of the Moon, obtained with the Great Melbourne Telescope, which is now suspended in the meeting-room of the Society. The bad weather has prevented him from doing much in photography with the large telescope since the date of that picture. But he has made very promising pictures of the Sun by means of a $4\frac{1}{2}$-telescope and an ordinary Huyghenian eye-piece, which enlarged the image to 5 inches in diameter. A picture of the Sun thus obtained on October 9, 1871, has been sent over, and is now with the Society. Mr. Ellery, however, intends trying a Steinheil's achromatized (actinically?) positive, that he possesses, with the view of obtaining more perfect pictures.

Lastly, Mr. Ellery has sent a negative photograph on glass of several drawings of the nebula in the neighbourhood of *η Argûs*. These drawings have evidently been made with great pains to ensure accuracy, and are very interesting. Astronomers will look forward with great interest to future observations of this nebula made with the mirrors when restored to the polish which they originally had when they left the hands of Mr. Grubb.

The material for volume iv. of the *Melbourne Astronomical Observations* is now in the press. The ordinary magnetical and meteorological observations have been regularly carried on without any notable change of method.

Sydney Observatory.

The general condition of the Observatory is considered to be in a much more satisfactory state than formerly, and the public interest manifested in astronomy, as shown by the number of amateur astronomers, with useful telescopes, is steadily increasing.

During the past year the transit instrument has been devoted to the usual meridional observations, including those of the Moon, and Moon-culminating stars, which were observed as often as possible. The equatoreal has been employed in the observation of the angular distances and positions of double-stars, and in the construction of a map of the nebula and stars about *η Argûs*. A photographic apparatus has been fitted to the instrument, and some good pictures of the Moon obtained.

The Sydney time-ball has worked steadily throughout the year, and the clock arrangement in connexion with the chronograph, on which the clock-signal and the return-signal from the ball are both recorded, has worked satisfactorily. Signals by the same contact have been regularly sent to the Newcastle time-ball, but owing to the length of wire (about 100 miles), many interruptions have occurred.

The difference of longitude between this Observatory and the town of Orange, about 150 miles from Sydney, has been carefully determined by galvanic signals. The latitude of Orange was also determined.

The number of meteorological stations in New South Wales has been increased to forty-two. The results from all these stations have been published monthly, and an abstract at the end of the year. The results from the principal stations are also published in the daily papers.

The self-recording meteorological instruments at Sydney, consisting of a barograph (photographic), an anemometer, two rain-gauges—one on the ground, and the other at an elevation of 65 feet—and the tide-gauge, have all worked satisfactorily. The self-registering tide-gauge at Newcastle has also worked satisfactorily, and it has recorded more earthquake waves than at Sydney, owing probably to the fact that the harbour is more open.

Some important experiments on evaporation have been carried on during the year. Magnetic observations have also been made at this Observatory, and at several country stations. A meteoric stone, weighing 145 lbs., which fell near Deniliquin some years since, has been secured, and is now deposited in the Observatory.

Mr. Russell took an active part in the organization of the Australian Expedition for the observation of the Solar Eclipse of December 11–12, 1871. It is already known that cloudy weather unfortunately prevented any observations being taken.

Preparations are being made for the observation of the transit of *Venus* in 1874 by the staff of this Observatory. It is intended

to erect two temporary observatories for the purpose—one near the south-east point of the Colony, and the other on the mountains west of Sydney. The Government of New South Wales have devoted 1000*l.* for the construction of the buildings, and for the purchase of the new instruments required for the observations.

Notes on some Points connected with the Progress of Astronomy during the Past Year.

Discovery of Minor Planets.

Twelve minor planets have been discovered since the last Annual Report, as follows:—

(118) *Peitho*, discovered at Bilk by Dr. R. Luther on 1872, March 15.

(119) , discovered at Ann Arbor, Michigan, by Mr. Watson, on April 3. This planet was observed by M. Paul Henry, of the Observatory of Paris, on April 9, before the discovery was announced in Europe.

(120) *Lachesis*, discovered at Marseilles by M. Borelly, on April 10.

(121) , discovered at Ann Arbor, by Mr. Watson, on May 12.

(122) *Gerda*, discovered at Hamilton College, Clinton, New York, by Dr. C. H. F. Peters, on July 31.

(123) *Brunhilda*, discovered also by Dr. Peters on July 31.

(124) *Alcestis*, discovered by Dr. Peters on August 23.

(125) , discovered by M. Prosper Henry, at the Observatory of Paris, on September 11.

(126) , discovered by M. Paul Henry, at Paris, on November 5.

(127) , discovered by M. Prosper Henry, also at Paris, on November 5.

(128) , discovered by Mr. Watson, at Ann Arbor, on November 25. This planet was independently observed by M. Borelly before the announcement in Europe of its discovery by Mr. Watson.

(129) , discovered by Dr. C. H. F. Peters, at Clinton, New York, on 1873, February 5.

The minor planets continue to be observed on all favourable occasions at Greenwich and Paris, according to the convention originally agreed upon by the Astronomer Royal and M. Le Verrier, and at some of the principal Observatories, both in Europe and America. Special notice may be taken of a volume which has lately appeared, containing the results of the observations of 48 minor planets, observed in 1871 by Dr. Möller, with the equatoreal at the Lund Observatory; the volume also contains